TECHNIUM
SOCIAL SCIENCES JOURNAL

Vol. 35, 2022

A new decade for social changes

ISSN 2668-7798

www.techniumscience.com

TECHNIUM SOCIAL SCIENCES JOURNAL

Technium Social Sciences Journal
Vol. 35, 263-284, September, 2022
ISSN: 2668-7798
www.techniumscience.com

The accessibility of visually impaired people to museums and art through ICTs

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Abstract. Human's involvement with culture is a vital part of his life, but what happens when someone is blind or visually impaired (VI) and how Information and Communication Technologies (ICTs) help the access to cultural locations? The difficulties and limitations that blind and visually impaired (BVI) persons face while visiting museums or art exhibitions are of high importance. These limitations concern both the access to the location and the perception of the exhibits. This bibliographic research is divided into four main parts. In the first part of our paper we will analyze the difficulties that these people face as visitors in art exhibitions and how their disabilities affect an autonomous visit. Afterwards, we will refer to the importance of the disability arts when combined with ICTs. In the next part, we will mention the projects that are already applied or those for which efforts have been made globally for their implementation. These will be accompanied by recorded feedback from blind and visually impaired visitors. Finally, we will make a scheduled visit to the Tactual Museum of Athens in order to collect material on practices used in their exhibition and we shall record reactions from visually impaired visitors.

Keywords. Museums, art, ICTs, visually impaired

Introduction

Blind and visually impaired people have long been excluded from artistic and cultural institutions such as art exhibitions and museums. Despite the growing concern and efforts that have been made in the last years, the majority of these institutions are still inaccessible to disabled people. As a result, "only 5.5 percent of blind and visually impaired people visit museums in Europe" [1].This is partially due to the visual centricity of these institutions [1] which creates barriers for visitors with visual impairments and deters their motivation to gain knowledge and socialize with their friends and family [2] in such spaces and contexts. In this article, which is based on bibliographic research, we aim to analyze firstly the lack of accessibility experienced by blind and visually impaired people in cultural institutions such as museums.

Today, new technologies can be used to address inaccessibility and create inclusive practices in the fields of Arts and Culture. The integration of Information and Communication

Technium Social Sciences Journal
Vol. 35, 263-284, September, 2022
ISSN: 2668-7798
www.techniumscience.com

Technologies (ICTs) in these fields offers the possibility to enhance access to artists and audiences that were until now excluded from artistic and cultural institutions [3]. For at least a decade, disabled artists have used ICTs in their creative processes. Our second section will focus on them and on the Disability Arts. Lastly, we will discuss and offer an overview of current practices using new technologies implemented by museums and art galleries in order to enhance accessibility for blind and visually impaired audiences. To conclude this final section, we will present some of the feedback that has been given by blind and visually impaired patrons concerning these practices.

I. Implications of the visual nature of art exhibitions and museums for Blind and visually impaired people

Ocularly-centered museums: Which are the difficulties blind and visually impaired patrons face?

As it is known, people with disabilities rarely visit museums due to mobility issues in reaching and navigating museum buildings and difficulties in accessing artworks [4]. This is because the museums remain mostly ocular centric oriented, which does not contribute to the engagement with exhibitions through other senses than vision, deprives their access to information and exhibits, and also hinders their independent mobility in the museum space [5]. Proper experience of an exposition for these people could only be available by approaching the exhibits literally in a hands-on fashion. In most cases, however, such direct contact with them is not possible due to the risk of damage. [6]

According to the social model, disability is not a product of pathology, but of specific social and economic structures that exclude people with disabilities from fully participating in mainstream social activities. In other words, the social model tried to introduce a new point of view regarding the impairments and difficulties turning the attention to the social barriers. [7].

The common feeling that the museum experience is mainly visual is by itself the main problem for the people who do not have access to the world's visual culture [8].

Hayhoe in his book claims that the VI persons are passively excluded from the museums without anyone taking into consideration their age and types of blindness. Subsequently, the understanding of blindness or visual impairment (the meaning of which differ depending on the apperceptions of each person and the cultural environment) will eventually lead us to to understand how these people perceive art. Dealing with art and cultural elements will eventually help them to strengthen their self-esteem and built a relationship with the past [1]. Candlin states that museums can include low-vision audience if they want to change how their exhibits are presented and claims that the VI persons are not treated as marginal group because of their low vision or its total absence, but because the opinion that the art is perceived only through the eyes, is still very strong [1].

Blind and visually impaired (BVI) persons tend to feel insecure in unfamiliar environments due to the uncertainty of the environmental context. So imagine how an ocularly-centered museum impacts on their psychology as visitors even upon their entering. Mobility barriers and the lack of accessible information, whose content usually includes visual descriptive terminology has a negative influence on them [1]. The absence of information (tactile information) that can be obtained through senses other than sight can reduce the quality of their visit [8].

A survey in United Kingdom focusing on best access practices of museums' websites proved that 81% of accredited museums in UK provided information regarding the accessibility

Technium Social Sciences Journal
Vol. 35, 263-284, September, 2022
ISSN: 2668-7798
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of the museum site through their website. However, these information was not sufficient for the VI people to plan an independent visit [1].

We need to understand the necessity and the importance of giving visually disabled patrons the opportunity to feel and understand art through their senses. If we do not take into consideration the cultural needs of these people and assist for their integration, that will result into burdening them with high costs in order to be hire escort assistance, which may gradually result to their exclusion from museum visits and other culturally relevant activities, because of the high financial cost [8]. The financial constraints that BVI people face are multidimensional and affect important sectors of their lives. The high cost of the special equipment they needed in order to have access to everyday things and services based on their needs, along with the lack of social support and sufficiently trained staff is also a sector we cannot overlook and it is important to come up with a solution. Most of the times the assisting staff provides services which do not meet the real needs of these people.[8].

Although, contemporary art is still evolving and the gradual development of multisensory technologies will give to BVI persons the ability to appreciate art through various senses (eg. hearing, touch and smell) and pave the way for quality cultural experiences through the life-enhancing power of art [8].

Lack of independence

The lack of independence when visiting cultural and artistic institutions is a great consequence of the barriers that blind and visually impaired visitors face. People with visual impairments often have to rely on their families and/or friends to visit museums and art exhibitions. During their research, S. Asakawa, Ahmetovic, Guerreiro, Kitan and C. Asakawa found that fourteen out of nineteen participants had never visited a museum by themselves. Those who had visited museums by themselves were assisted by museum escorts or had attented specialized tours for blind and visually impaired people. Therefore, their ability to visit these spaces is highly dependent on the assistance they receive either from their families/friends or from the museum personnel, and their availability [9]:

““I depend too much on them [their family and friends], but if there were specialized services in the museums, I could make arrangements by myself” [10], and “I don’t want to make an appointment three weeks ahead” [1]

Yet it is important for blind and visually impaired people to have more control and autonomy over their museum experience, in the same way that non-disabled people do. Naturally, lack of independence strongly impacts the quality of their experiences in those cultural and artistic institutions, firstly because the quality of the description is highly dependent on the person providing them [2,9]:

“It depends on who you go with. Some people are very expressive and they are very descriptive. But other people are...not really giving me much...They don’t know exactly what I wanna know.” [9]

Secondly, because they are often dependent on personnel who are not trained to receive a disabled audience and they may thereby be exposed to ableist and unwelcoming behaviors. [1]

Art and technology alike can play an important role in creating access to worlds that are otherwise unavailable for blind and visually impaired people [11]. We will now focus on how disabled artists exercise agency, particularly through the use of technology [11].

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Vol. 35, 263-284, September, 2022
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II. Disability Arts using ICT and digital technology

Disability Arts

Through their artistic and creative practices, disabled artists have – sometimes unwillingly – opposed to the medical model of disability that emphasizes and perpetuates a passive image of individuals with disabilities. Hence, according to Sarah Heussaff, disability arts are socially and politically engaged [12]. According to Swain and French:

"Through song lyrics, poetry, writing drama and so on, disabled people have celebrated difference and rejected the ideology of normality in which disabled people are devalued as 'abnormal.' They are creating images of strength and pride, the antithesis of dependency and helplessness (2000)" [13]

Disability Arts have played an important role in expressing a positive disability identity [13] and thus in the individual and collective empowerment of disabled persons. As Walker described in 1998 during the National Arts and Disability Center online conference, Disability Arts have strongly impacted Disability Culture, which:

"is made up of artists who are not trying to pass, artists who don't buy into societies [sic] rule that we should be ashamed of our disabilities, artists who often show in their art a self-acceptance and a pride about who they are, not in spite of a disability, not because of a disability, but including a disability." [13]

Therefore, according to Heussaff, disability arts are also practices that enhance self-representation and self-organization [12].

For at least a decade, disabled artists have been using new technologies in their artistic and creative processes and they have widely contributed in the field of Digital Arts. For Al Zidjaly, art combined with technology may represent an opportunity for disabled people to create not only personal but also social change (2011). In this section we want to point out that ICTs can be and are being used by disabled actors themselves in order to create art that is both for disabled and non-disabled audiences, but also in order to enhance accessibility. By combining art with technologies, disabled artists are exploring multimodal artistic practices and they create their own creative and inclusive aesthetics. In spite of society's perception of artists, they are proving that "great art can be created or interpreted with senses other than our eyes" [14].

We will now offer a brief overview of blind and visually impaired artists who use ICTs in their artistic and creative processes.

Overview of blind and visually impaired artists

Keith Salmon and The Oregon Project

Keith Salmon is a landscape blind artist who uses sound recordings. For him, "painting isn't about capturing what a place looks like but how it feels" [14]. Thus, in his work he tries to convey parts of his experience: "the cold, the shimmery light, the wind" [14].

In 2016, Salmon collaborated with Microsoft on the "Oregon Project", an interactive audio-visual experience that used proxemic audio to interpret two-dimensional images. During the exhibition, four Kinects and fifteen overhead speakers that played a total of 54 soundtracks were installed in order to produce an acoustic and spatial interpretation of Salmon's paintings [15]. The aim of the installation was to create a holistic personal experience of the artworks for people both with and without vision impairments. The paintings, which depict the remote Hells Canyon, are brought to life through the different sounds that are triggered by the Kinects' track of movements:

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Vol. 35, 263-284, September, 2022
ISSN: 2668-7798
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"From afar, observers can hear birdsong, rushing water and grass swishing in the wind — recorded in Hells Canyon by Salmon and his collaborators. Moving closer activates digital tones matched to Salmon's palette of blue, green, brown and ochre. Stand even closer and you can hear Salmon working in his studio as he scribbles pastels on paper, in an experience that parallels how a sighted person can see details when leaning in. The Kinects also track hand waves to change what you hear, helping observers become part of the piece and make their own acoustic mixes with movement. At the exhibit, adults triggered sounds primarily by walking, while kids jumped and waved their arms to produce a different blend of noise." [15]

Figure 1: "Artist Keith Salmon, left, and Microsoft researcher Neel Joshi stand in front of "The Oregon Project" at the King Street Station in Seattle. Photos by Dan DeLong" [15]

Hal Lasko, "The pixel painter"

Hal Lasko, also known as "The Pixel Painter", was a typographer and an artist who suffered from wet macular degeneration that caused him blindness in the center of his vision. Lasko created his art pieces on his computer using Microsoft Paint, a program that, thanks to "it's easy interface and pixel precision allowed Hal to journey down a new artistic path with a style many consider "retro cool" (https://thepixelpainter.com/).

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Vol. 35, 263-284, September, 2022
ISSN: 2668-7798
www.techniumscience.com

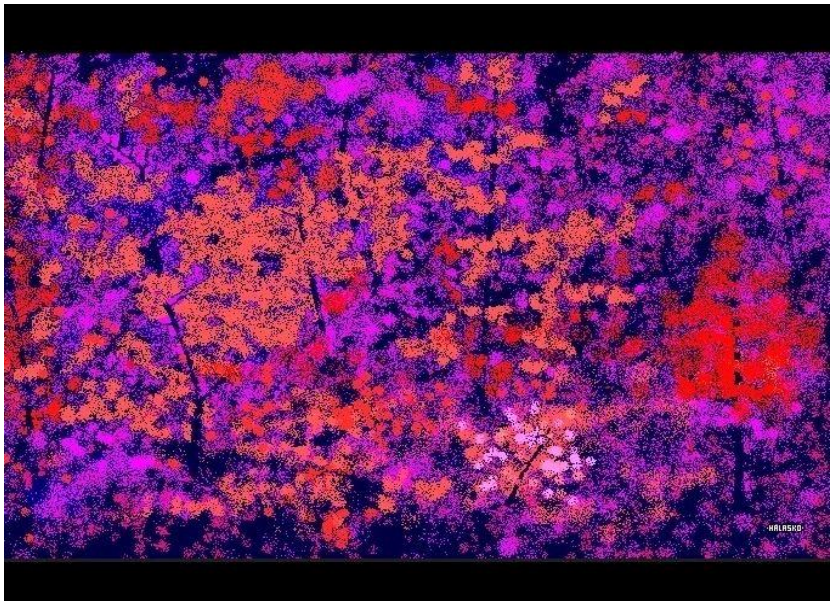

Figure 2: "Red October" by Hal Lasko

III. Increasing access for blind and visually impaired museum visitors: an overview of current practices.

Visually impaired people have difficulty in visiting museums. For this reason, various researchers have tried to find solutions through ICTs so that these people have equal rights and do not feel excluded from social and artistic activities.

(a) **Augmented Reality, the Mobile App MusA and 3D printings**

The first tool of Information and Communication Technologies which has been used is the Augmented Reality (AR) and the ways it can help people with visual impairments or blindness to navigate in a museum. The researchers try to discover and analyze the ways in which AR could facilitate the access of visually impaired or blind people in the museums and the construction of positive experiences. In the process two questions have arisen and they are relevant to how the museums could create inclusive and accessible spaces for visually impaired or blind individuals. As for AR there is no a standardized definition. The most used one refers to different virtually mediated environments and virtual reality technologies. Some researchers characterized it as a "mixed reality" because it is in the middle of completely virtual environments and completely real world. The AR technology is accessible through mobile applications and it can provide either updated information of satellites or static ones of a specific location or object. In particularly, AR combines audio, haptic, gustatory and olfactory information through verbal descriptions, AR Avatars etc., which could help these people to create a picture of what is presented. As far as affordances it concerns, the researchers refer to a combination of eight properties: authenticity, collaborative affordance, connectivity, student centered, community, exploring situation, sharing knowledge and multisensory. All these properties can help visually impaired or blind people to have access at auditory information about the surrounding space and therefore they can easily navigate in it. The researchers, also, engaged in the thematic analysis which was conducted in the terms of the research. From this analysis four themes emerged:

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Vol. 35, 263-284, September, 2022
ISSN: 2668-7798
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Stage of development
How Are Disabled People Involved in the Research?
The (Potential) Impact of AR on User Experience
Fun and Enjoyment/Function, Not Fun

It is shown that significant steps have been made in order virtual impaired of blind people have access to museums through Augmented Reality. This could help them to acquire positive experiences and knowledge [16]. Furthermore, the second tool is an inclusive mobile app MusA which aims to assist people with low vision to have access to the museums and their artworks. This app contributes to this supporting LV people in accessing 2D visual artworks, such as paintings, through interactive artwork descriptions in Augmented Reality. Although some questions have arisen during the development of MusA however it was shown that this app is effective in supporting people with LV during artwork accessibility. More specifically, the participants were able to easily frame the target artworks with their mobile device camera, to access the visual feedback provided in AR and also to interact with the visual information shown in AR. In order this app to work, the "Associazione Nazionale Subvedenti" (ANS) used the methodology of DescriVedendo descriptions of the artworks. The analysis focused on addressing the problem of how museum visitors can access DescriVedendo during a visit resulting in the following requirements: 1. It should be accessible from visitors' own devices. 2. It should be accessible to people with LV. 3. It should help the user quickly fnd descriptions. 4. It should help the user navigate the description. 5. It should augment descriptions with visual information. 6. It should work in multiple museums, for all artworks with DescriVedendo descriptions. At the end the researchers set as future goal to make MusA available to iOS and Android users and to include DescriVedendo descriptions that are currently available for artworks exposed in 8 museums [4].

In addition to the previous technologies, some software was created in order to serve the needs of these people. So, the researchers propose some guidelines in order to create a framework for improving the museum experience and access of blind and low vision individuals [5]. Firstly, they analyze some tools which are used to help people with blindness or low vision to have access at the museums. Some of these tools are: 1. Geomagic Touch System, which helps these people to explore 3D virtual copies of museum artworks by touching them. 2. The Probos Sensory Console with which the blind or low visual persons have the opportunity not only to touch virtual 3D objects but also to hear sounds which were related to them. 3. Tooteko which provides a tactile exploration of the exhibits by wearing a ring sensor. 4. Blind Museum Tourer which was designed for the Tactual Museum of the Lighthouse for the Blind of Greece, the National Archaeological Museum and the Acropolis Museum and it was used for physical access and indoor navigation. Furthermore, the researchers conducted a research in order to see how the visual impaired or blind people want to enhance their access at the museums. So, at this research semi-structured interviews were used to collect the data and 72 individuals voluntarily participated in. From these the 61,1% were blind and the 38,9% had low vision. The participants considered that in order to have an easier access to the museums and their artworks, they should proceed with 3 phases: pre-visit, on-site visit and post-visit. At the end, the proposed framework does not intend to replace the accessible guided tours but to use technology in order to allow people with low vision or blindness to have easier access to museums and their exhibits.

Finally, as a last medium to help people with vision problems is 3D printings. These people in order to "see" the exposition need to use their hands, but this is not possible because damage can be caused. For this reason, museums tried to create "touchable" models of the exhibits. To so, they used the method of 3Dprinting. This, however, has one disadvantage. They

cannot reproduce precisely the model as it is in reality. More specifically some steps need to be made in order to prepare an exhibition through 3D printing. These steps are eight: 1. Selection of the objects, 2. Selection of the 3D scanning technology, 3. Preparation of the documentation, 4. 3D scanning, 5. Postprocessing, 6. 3D printing, 7. 3D print processing and 8. Preparation of the exposition. Moreover, the researchers present the implementation of the above steps for the construction of an exhibition with sculptures from the mid-20th century. At the first stage, the museum's staff selected 10 sculptures from the exhibition. At the second stage, they assessed the dimensions and shape of the sculptures in terms of scanning technology. The objects that used for scanning were mobile scanners which were facilitating the process. However, the precision of the scanning was too low so that the museum's staff was obliged to use additional markers in order to have the desirable result. At a later stage the staff indicated special features of the objects, which were significant for the preservation of the nature of the exhibition. These features were noted in order to ensure that they were properly displayed during 3D printing. Moreover, research was carried out at the headquarters of Polish Association of the Blind in Lublin and it was expected that a visual impaired or blind person to recognize the 3D printed sculpture without any additional information about it. Thus, the aim was to check the possibility of recognizing the exhibit, to assess the correctness of the 3D size of copies and to assess the suitability of the material used for 3D printing [6].

(b) **Audio description and assistive navigation**

The barriers that blind and visually impaired visitors may face inside museum spaces are often related to the inaccessibility of the exhibition objects and artworks, as well as to mobility issues such as navigation and orientation [2,17,9,1]. For these reasons, among the most common technological solutions provided by museums to enhance accessibility for blind and visually impaired patrons there are audio guides that offer verbal descriptions of the exhibited items and indoor navigation systems [9,1].

"Besides helping to create new ways for visually impaired and blind visitors to interact with museum collections while learning more about them, technology is also being used to provide them better physical access, indoor navigation and wayfinding in those environments, enhancing their ability to move independently through different galleries, without the aid of guides or another escort." [1]

In addition to this, accurate navigation assistance of blind and visually impaired visitors is important since, as observed by Asakawa et al, they value listening to audio content while they are in front of the respective artworks and not just near them (2019). Thus, many museums have developed systems that combine audio description of the exhibitions and accurate navigation services. We will now offer a brief overview of these hybrid solutions.

Blind MuseumTourer, Tactual Museum of the Lighthouse for the Blind (Greece)

The Blind MuseumTourer is an application that runs on Android phones and uses Bluetooth Low Energy (BLE) beacons and tactile floor tiles in order to accurately locate visitors and help them navigate independently within the museum environment [17,9]. It was developed by Meliones and Sampson for Greek museums and it was firstly implemented at the Tactual Museum in collaboration with the Lighthouse for the Blind of Greece [17]. The application is initiated through voice command or by tapping on the screen. In the main menu (figure a) visitors can find vocal presentations of possible routes they can take, as well as emergency and back options. System interactions were based on a single-tap for hearing a selection, double-tap for confirming, or through voice command. Selecting a route initiates the self-guided tour and when exhibits are approached by the visitor the application launches a description. [17,1]

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ISSN: 2668-7798
www.techniumscience.com

Figure 3: Blind MuseumTourer Android application activities: (a) Main menu and Route selection (b) Emergency; (c) Get voice way-finding instructions to move to the WC/canteen/exit.

National Science Center of New Delhi (India)

At the National Science Center in New Delhi another mobile device was developed in order to enhance accessibility for blind and visually impaired patrons. Users of this device have the option of selecting vocally their destination and are then presented with step-by-step navigational audio instructions while they are walking. "When the visitor is near an exhibit, an infrared tag is received by the device and a description of the piece is presented" [1].

Figure 4: Picture of a visitor navigating with the application's help at the National Science Center of New Delhi

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ISSN: 2668-7798
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Andy Warhol Museum, Pittsburgh (USA/ Adena's, Hopewell's, and Monongahela's Territories)

In order to support and facilitate both navigation within the museums and accessibility of the exhibits, Asakawa et al. developed a smartphone app with two interaction modes: Navigation and Art Appreciation. The activation of each mode depends exclusively on the user's location and orientation (2019). Thus, the application uses BLE beacons and the smartphone's sensors to accurately localize the user [9]

"During Navigation Mode, users receive turn-by-turn instructions to proceed in the intended path while being alerted about the artworks they are passing by. Art Appreciation Mode is activated when the users are next to an artwork and turn their body in order to face it, while Navigation Mode is resumed after turning their body to the previous orientation. When the user is within close proximity of an artwork, changing between modes depends on the user's orientation." [9]

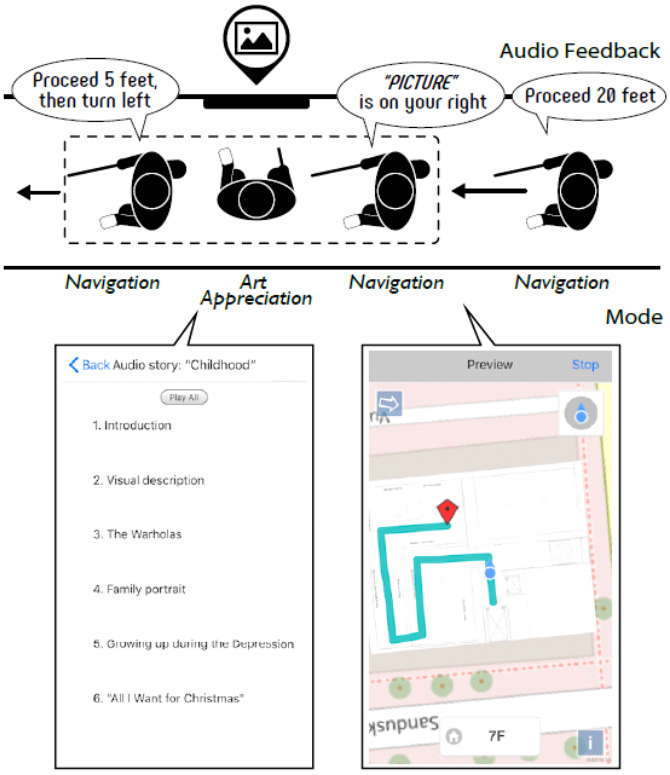

Figure 5: "It shows the interaction between Navigation and Art Appreciation modes based on the user's location and orientation, with example audio feedback and screenshots of each mode" [9].

In order to evaluate their application, the researchers installed the system at The Andy Warhol Museum in Pittsburg and conducted a user study following nine blind and visually impaired participants. During their research, Asakawa et al. found that the quality of the audio content is a crucial factor in the experience that blind and visually impaired patrons have within cultural and artistic institutions. Thus, the audio content that was used for this study was created by the museum's personnel when designing their inclusive audio guide, OutLoud – which supports auditory descriptions, but not navigation [9]. Also, the application gives the possibility

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to the user to navigate through the audio content by performing gestures on the touchscreen: "for instance, a single tap would pause/resume, while right and left swipes would change to the next and previous chapter of an audio story, respectively" [9]

Interactive multi-model guide

The multi-sensory interaction aids learning, inclusion, and collaboration, since it accommodates the diverse cognitive and perceptual needs of the VI [18]. Rare individuals naturally have sensory crossover, whose synesthesia1 [19] permits them, for example, to see colors or shapes when hearing sounds or to sense a specific taste with a specific word [20]. Many scientists, technologists and inventors, however, make a conscious attempt to convert one type of sensory-like input to a different sensory output [18].

Interactive multi-model guide

An Interactive multi-model guide developed by Cavazos et al, using 3D technology, transformed a flat painting into a 2.5D, combining it with touch, audio description and sound. The various visual elements in the work such as ambient sounds that reflect periodic, seasonal, temporal and regional information about that work provided a high level experience to the users. An important difference except for the multi-sensory experience it provides, is that the BVI persons can use it freely without the help of a professional curator which, as we mentioned previously, is really important for the BVI persons. Also, the gamification factor added in this project maximizes the fun part of the process and stimulates the other senses. Each artwork in this project was reproduced with materials that can perceive the haptic touch; so with the fist tap of the user on a specific area of the artwork, the user hears an audio description of that part and immediately gets the information about the names, color or shapes of the objects, the location ; with a second tap they are able to hear a sound effect about that part (such as sounds related to the landscape depicted, nature's sounds such as sounds of leaves, which may refer to the autumn, etc.) . The use of natural sounds stimulates the emotions, while the musical background which creates emotions similar to those expressed in the artwork immerses them in the content of the painting. Also, with the placement of two-dimensional speakers the individual is mentally integrated in the physical context of the artwork and is able to understand his position in relation to the artwork's environment. Finally, with the touch of a physical button, they are able to hear a recorded track containing use instructions and general information about the artwork, such as the painter's historical and social context, which is an essential part of understanding any work. [8]

BlindTouch artworks exhibited for three weeks at St. Mary's School (special school for the visually impaired, located in Cheongju, Korea). The participants in the Blindtouch exhibition interacted-among other artworks-at Vincent van Gogh's 1889 painting, "The Starry Night" Once the users touch the BlindTouch painting two times, a sound which imitates the starlight and the sound of a tall cypress swaying in the wind is produced. The sound of the wind was played through two speakers to express the swirling movement of the wind, and the moonlight and starlight in the sky at the top of the work were expressed as a twinkling ringtone. The sounds of shaking leaves and grass bugs on a summer night were also added. To those

[1] Synesthesia is a perceptual phenomenon in which stimulation of one sensory modality evokes additional (usually) sensory experiences in an unrelated modality (e.g., sounds evoking colors). [19]

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sounds, background music was added with an atmosphere similar to the emotions inspired by "The Starry Night". To express the warmth coming from the village, an oboe played a major scale, and a slightly fast, lyrical melody in the high pitch range of the piano provided a cold feeling of dawn. The completed exhibition environment used six-channel speakers arranged on flat plates, and the wind sounds were swirled between two speakers to arouse a sense of space and enhance appreciation of the artwork through a sense of three-dimensional sound (Figure 6). [8]

Some participants who interacted with Van Gogh's "Starry Night" referred the below:

"I'm so happy that I can now tell my friends that I understand Starry Night better through the blind touch. Thank you for making art more enjoyable. Especially when I'm older, it's so interesting because I can remember it in a different way."

"It feels like the wind is fighting with each other"; "The sound is played from side to side to express the feeling of wind blowing"; "There is a lot of wind and it feels cool and cold in the air." [8]

Figure 6. A blind student viewing the "Starry Night" by Vincent van Gogh reproduced in 2.5D at the BlindTouch exhibition exhibition (Cheongju St. Mary's School)

(c) Haptic Devices for the Exploration of Virtual Copies

In most of the cases the artifacts in museums or galleries are seldom available for manual manipulation; haptic interfaces provide a potential solution to the problem of making three-dimension work of arts available for manual processing [21]. In their essence haptic interfaces provide kinesthetic force feedback to the users in order to perceive information such as shape, weight, texture and material properties while manually exploring three-dimension virtual objects or computer-generated environments. These devices were firstly used for the exploration of complex graphical environments, but because of their kinesthetic sense were considered as a suitable auxiliary tool for blind and people with poor vision. Haptic devices allow visitors to explore tactile visual replicas and also offer the ability to solve the issue of some museums face regarding the storage of duplicate exhibits (physical replicas and original exhibits). [1]

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The European Union Project Museum of Pure Form had as an aim to develop a haptic display by converting sculptures from different historical periods and from the collections from different museums into virtual replicas. This effort was presented to the public in temporary exhibitions and gave the visitors the ability to experience the assets of the digitized artifacts. For that reason the visitors were provided with an arm exoskeleton, for force feedback on the upper limb and a haptic interface for fingers, in order to exert a force of direction on the fingertips, integrated in the lower part of the arm (Figure 7a). [1]

Experiments after the use of this practice have shown that the users had a pleasing experience, although many of them commented that the time to adapt the haptic system and set up the device needs to be decreased. They also claimed that the haptic display would be more useful if verbal information were added when the users touch specific parts of the artifact. [1]

The National Museum of Transylvanian History of Cluj-Napoca also digitized three-dimensional objects, which were experienced through the Geomagic Touch System. Geomagic Touch System is a more recent haptic device installation, is a simpler and cost effective system proposed by Comes (2016). Users in order to interact with the virtual object pick up a pen associated the device, which applies force feedback on their hand. In that practice no hardware device is mounted on the users body, on the contrary with the previous case we presented. In order to optimize the experience, multiple texture layers where integrated when necessary, so that the user can feel with enough accuracy the details of the virtual surfaces he or she is touching. [1]

Probos Sensory Console, is a project which is developed in the context of the European Union project AMBAVis and also uses that fore-mentioned type of technology. That project aims to enable access to museums and galleries around the world and collaborates with the Manchester Museum, UK, and Gallery Belvedere, in Vienna, Austria. In that project too we have the use of a stylus, which the visitors hold between their fingers. In Probos Sensory Console we have the addition of the hearing sounds while making contact with the object and vocal instructions, which were not applied in the previous projects we have mentioned (Figure 7b). [1]

Experimental results on blind persons showed that they found it difficult to navigate in order to find the virtual objects and perceive the sense of distance or the perspective of the virtual space. [1]

Figure 7: From Left to Right: a) A Visitor Using the Pure Form Exoskeleton System to Interact with Virtual Statues;b) A User Exploring a Digitalized Object [Vaz, Freitas, Coelho, 2020]

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Vol. 35, 263-284, September, 2022
ISSN: 2668-7798
www.techniumscience.com

(d) **Feedback from blind and visually impaired persons regarding the practices**

When it comes to art collection access, BVI visitors expect physical, intellectual, and sensory access to exhibits. This can be provided by multisensory experiences enhanced with appropriate contextual information, using a means of communication that allows the conceptualization of accurate mental images. In order to have choices that are more independent and feel confidence inside museum spaces, facilities for the orientation and mobility are also required [1].

After the overview of the fore-mentioned ICT practices let's see how BVI persons responded to some of them. When it is possible to have a hands-on approaches to art exhibitions,-as the visitors claimed- those experiences are limited to curators' and other museum staff's selections, and tend to represent only a very small fraction of the main collection, when compared with all the information available to sighted visitors [1]. In fact, there is a consensus about the importance of touch for somebody with a visual impairment, as it is the essence of their access, understanding and construction of mental images of museum artifacts. When an object is touched, different maps of the central nervous system are activated regarding the movements through which the object is examined, the physical properties that activate the tactile sensors, and the humoral and visceral reactions that form the emotional response to the object. This exploration results in neural patterns that allow individuals to be aware of objects [1].

Those dimensions are emphasized by several participants in Argyropoulos and Kanari's research.

"Touching exhibits in a museum is magic, is a mystery. I will never forget this experience. When they describe me the exhibit it's quite possible to forget it; on the other hand if I touch it then this experience stays on my mind, since I had the chance to touch, I could develop my own critical thinking, expand my own horizon, and "when you touch the exhibits you create first the outline of the object in your mind and then you add some attributes regarding texture, temperature and stuff." [10].

That specific last sentence emphasizes on the importance of touching the artifacts not only for the VI but also for the common visitor. That multisensory experience can lead to a better understanding of the materials, shape, texture and even odor. This exploration results in neural patterns and emotional connections that allows individuals to connect with objects and places of the past, as this is the main reason of the existence of the museums [1].

Even though the general positive feedback on that practice some of the visitors said that some information are still lacking when haptic experiences are provided. At this point, Hayhoe in his book Blind Visitor Experiences at Art Museums (2017) emphasizes that BVI visitors are not able to sense the museum object only by touching them. Additional information is of high importance in order to understand the whole exhibit context (the same implies for the typical visitors as well). Braille descriptions, bas-relief images along with audio description are additions that really make a difference [1]. However, a problem that may arise from audio descriptions is that the descriptions might be written in ¨visual language¨, which people with vision problems cannot fully understand. As a visitor during Hayhoe's research (2017) at the Metropolitan Museum of Art in New York referred:

"I don't have a visual image [of the painting being described]…You see that's the problem with the culture [of description]. It depends on who is describing it to you" [1]

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Vol. 35, 263-284, September, 2022
ISSN: 2668-7798
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Also, participants in Neve's (2012) and Candlin's (2003) research pointed out that since BVI visitors get in touch with the artifacts probably for the first time, they need to have specific guidance on what they touch and how to touch it. [1]

Also, in Reich et al (2011) BVI patrons claim that technology can make their museum experiences more positive and inclusive even without the support of the museum staff. [1]

Conclusion

The incorporation of digital technologies in education domain as well as in inclusion domain for supporting people with disabilities is very productive and successful, facilitates and improves the educational procedures and accessibility via Mobiles [26-35], various ICTs applications [36-68], AI & STEM [69-80], and games [81-86]. Additionally the combination of ICTs with theories and models of metacognition, mindfulness, meditation and emotional intelligence cultivation [87-110] as well as with environmental factors and nutrition [22-25], accelerates and improves more over the educational and supportive practices and results.

Moreover it is a fact that Internet Access by Visual Impaired or Blind People is a further part of life. However, seems to be in an extent degree excluded from social and art life. People with disabilities rarely visit museums due to mobility issues in reaching and navigating museum buildings and difficulties in accessing artworks [4]. This is because the museums remain mostly ocular centric oriented, which does not contribute to the engagement with exhibitions through other senses than vision, deprives their access to information and exhibits, and also hinders their independent mobility in the museum space [5]. So, for people with ID, the promise of the ICTs requires a long way for full social, entertaining and spiritual inclusion. Assistive technology (AT) can play a major role in overcoming the barriers that persons with visual impairments have to face as it is gaining increasing importance in the process of accessibility at the museums for the people. In addition, the usefulness of ICTs was proven through programs and software by visually impaired people. This research suggested that the ICT programs and software can facilitate the accessibility at the museums and the sight of the exhibits by visual impaired or blind individuals and the suggestion was to be further research in order to find out how the accessibility can be enhanced. Example is "MusA", an inclusive mobile app which aims to assist people with low vision to have access to the museums and their artworks.

As far as Individuals with visual impairments are concerned, the "Oregon Project" is an interactive audio-visual experience that used proxemic audio to interpret two-dimensional images. Also, another program is Using of Color-Concept Directed Scent

for Visually Impaired Individuals to Appreciate Paintings (2020) assumed that each scent has its own relation with color and concept, which the researchers called color directivity and concept directivity, respectively. Another important technology tool Blind Museum Tourer which was designed for the Tactual Museum of the Lighthouse for the Blind of Greece, the National Archaeological Museum and the Acropolis Museum and it was used for physical access and indoor navigation.

Finally, the use of computers and assistive devices strengthens the self-independence and socialization of visual impaired people. It is obvious that researches have shown that governments should organize ICTs at museums and art in order to bridge the gaping accessing ICT among different individuals and social groups.

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Vol. 35, 263-284, September, 2022
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